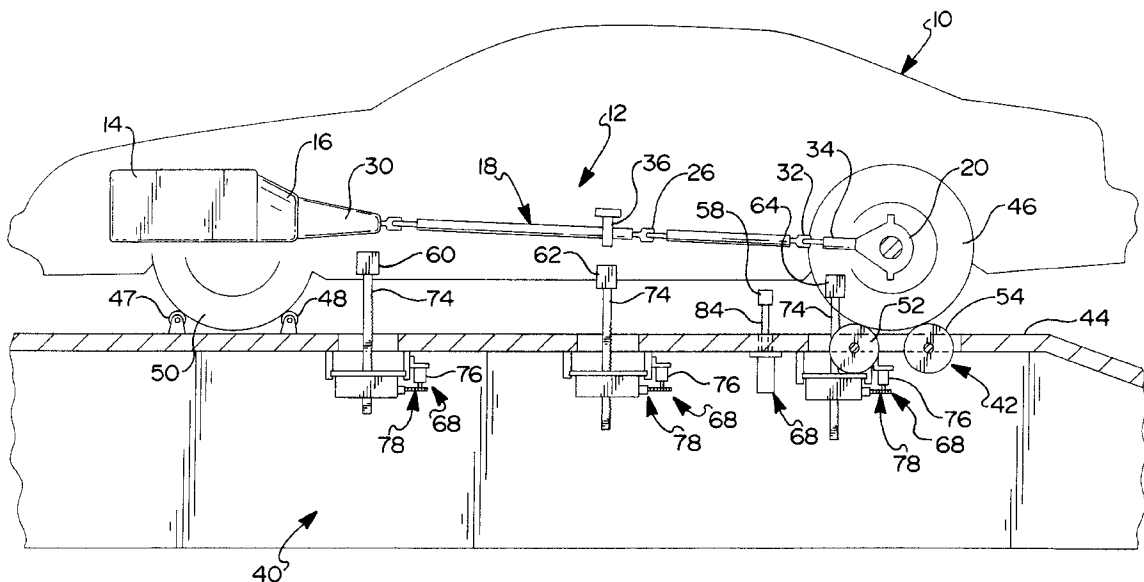


Kopp et al.

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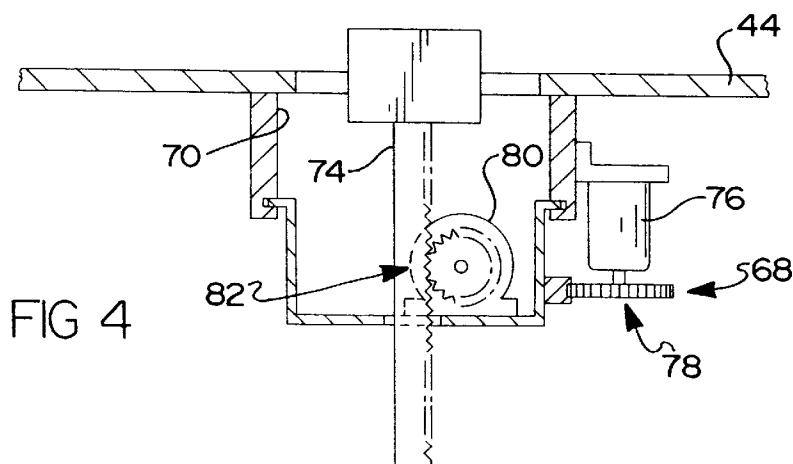
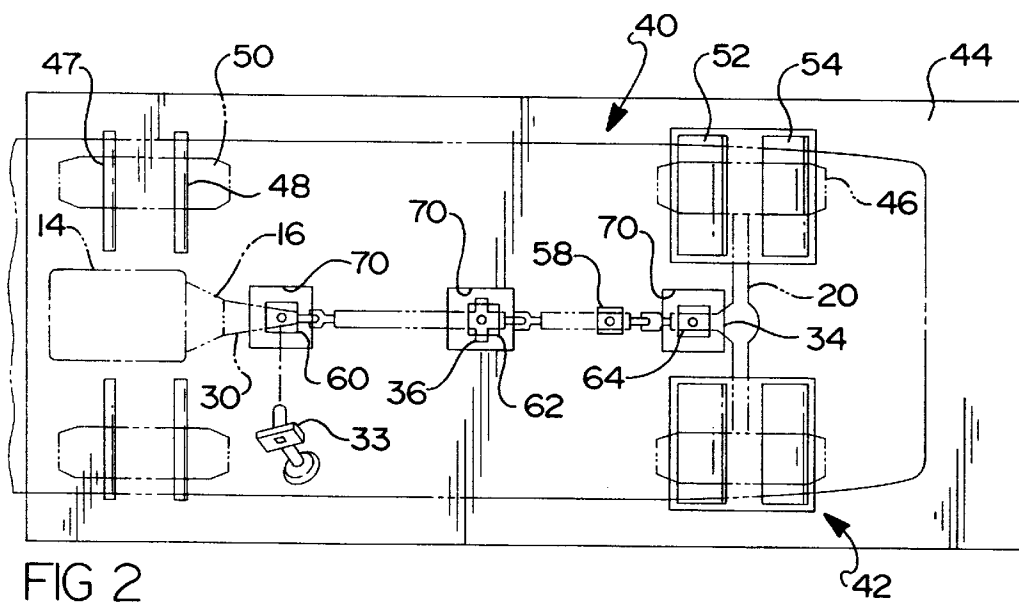
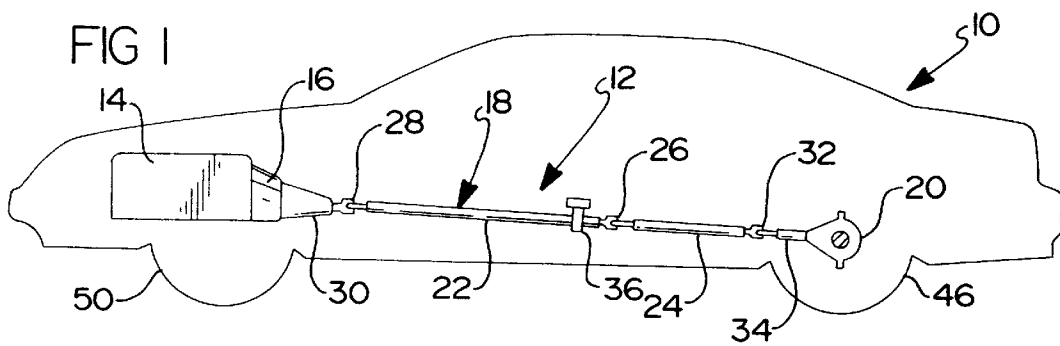
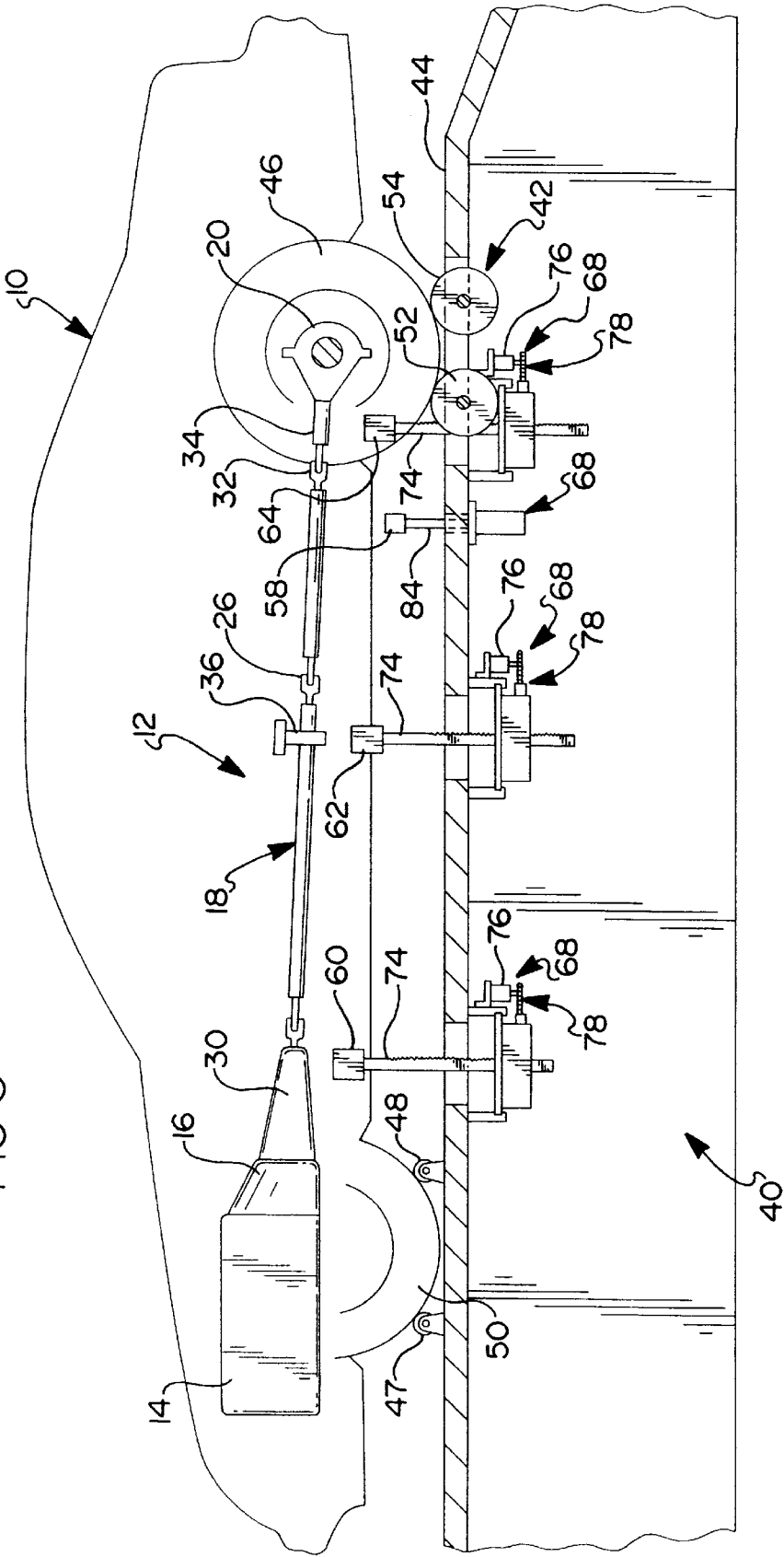
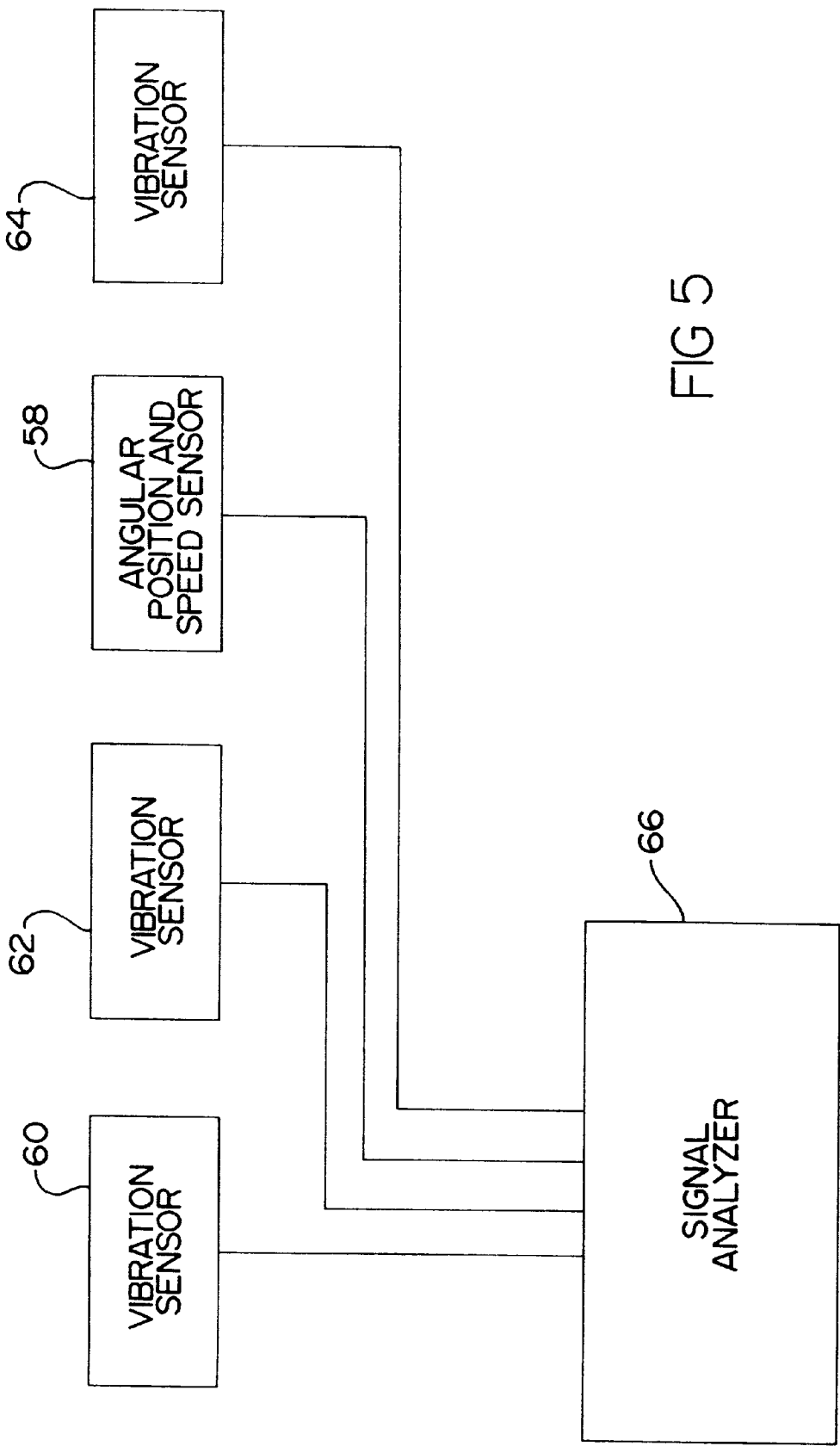
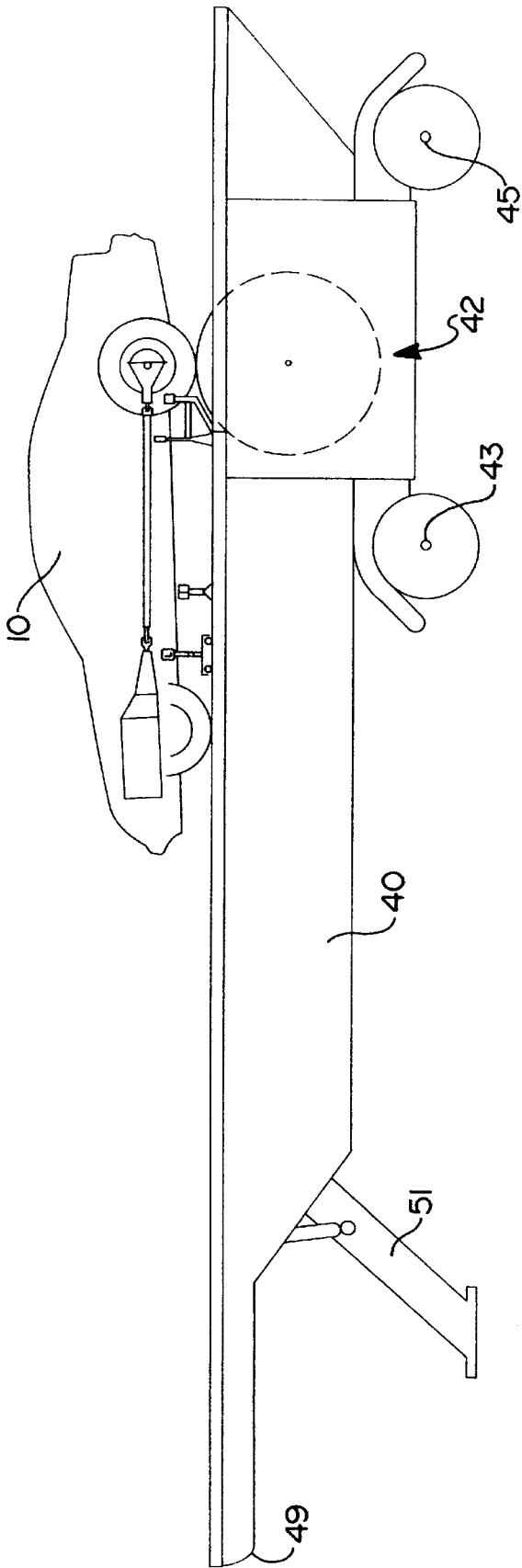
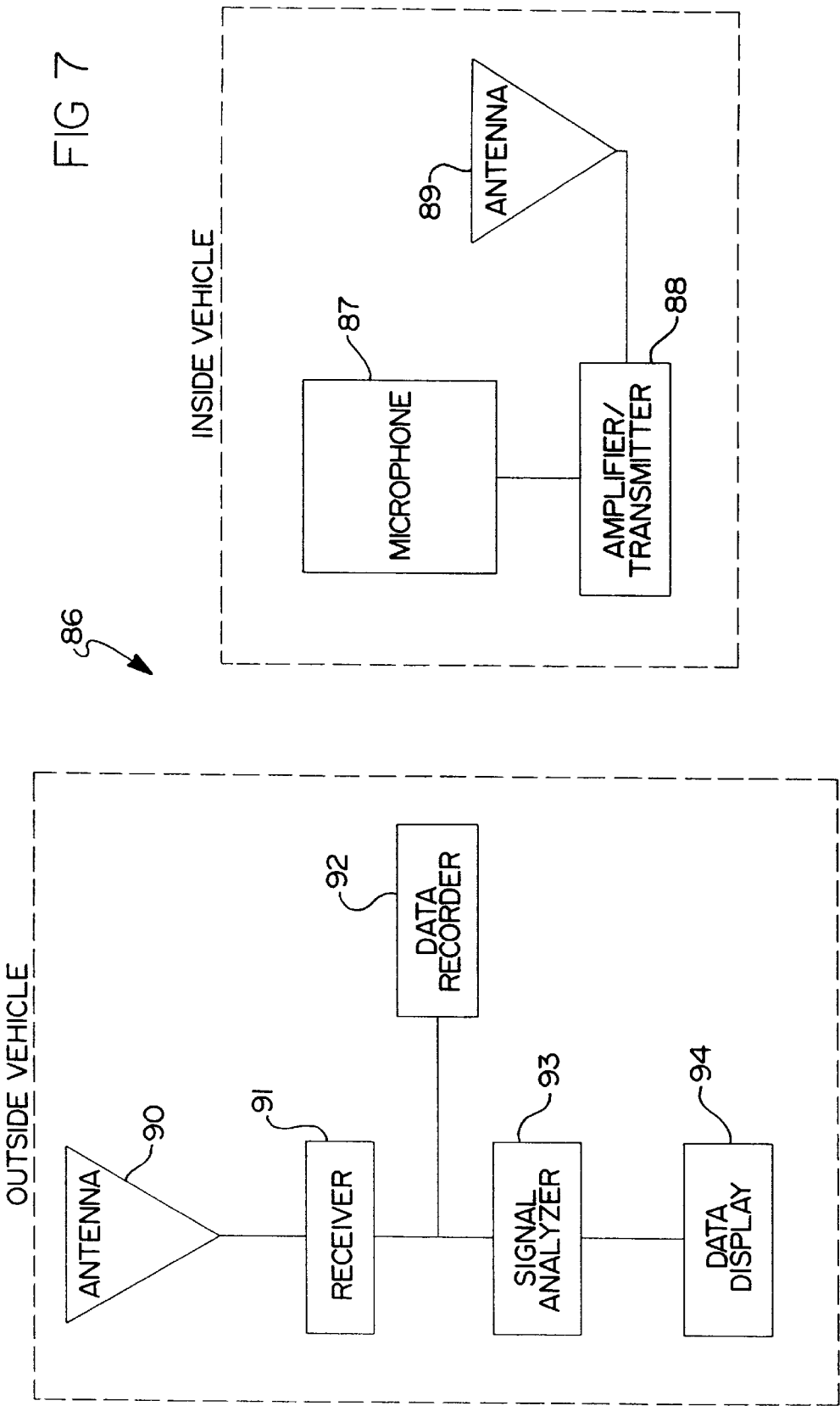


FIG 3









TRANSPORTABLE VEHICLE TESTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a method and transportable apparatus for detecting vehicle noises and vibrations in dynamic situations. More specifically, the present invention relates to a transportable method and apparatus for detecting system imbalances in a drive line assembly for an automotive vehicle using non-contacting vibration sensors.

2. Description of the Related Art

Generally speaking, automotive vehicles require three basic components: a power plant, such as an internal combustion engine, a drive line system or drive train, as it is sometimes known in the art, and a plurality of rotatably driven wheels. A typical drive line system may include a transmission, a drive shaft and an axle connected between the engine and the driven wheels. Engine torque and speed are converted in the transmission in accordance with the tractive-power demand of the wheels and translated to the drive shaft. In turn, the drive shaft transmits rotational power from the transmission to the driven wheels via the axle assembly. The axle assembly includes a differential which is operatively coupled to the drive shaft through a pinion gear. A pair of output axle shafts connect the differential to the driven wheels.

The drive shaft typically includes an elongated tubular member which is operatively coupled to the transmission and axle assembly through a pair of universal joints or other similar coupling disposed on either end of the shaft. Alternatively, the drive shaft may include two or more elongated tubular members which are connected together by a universal joint or some other similar coupling device and connected between the transmission and axle assembly as above-discussed. Additionally, a center bearing is often employed between the transmission and axle assembly to support the drive shaft relative to the body of the vehicle.

The individual components of the drive line system discussed above often include inherent or residual imbalances due to variations in manufacturing tolerances. While steps can be taken to balance the individual components, residual imbalances often still remain. When the individual components are assembled into the drive line system, the residual imbalances can "stack up" such that they combine to produce a relatively high level of imbalance. Automotive drive line systems which embody these characteristics are unacceptable because they produce drive line vibration and boom.

It is known in the related art to balance the drive line system prior to installation into the vehicle. Many fixtures are known in the art for performing this function and typically rely on vibration measuring devices physically coupled to the drive line system to identify and thereafter correct the imbalances.

Still, this is often not enough to eliminate objectionable vibration in the drive line system of a fully assembled automotive vehicle. Thus, devices have been proposed in the related art which seek to identify and correct drive line system imbalances at the terminal stage of vehicle production and prior to shipment of the vehicle. However, these devices suffer from the disadvantage that an additional step in the manufacturing process must be added in order that vibration sensing instrumentation can be physically coupled to the drive line system of each vehicle. This is time

consuming and labor intensive. In short, drive line system balancing as employed in the related art for a fully assembled automotive vehicle is presently not cost effective.

U.S. Pat. No. 5,641,904 to Kopp, et al, assigned to the assignee of the present invention ('904 patent), which is incorporated herein in its entirety, describes an apparatus which can detect and perform drive line system balancing in a fully assembled automotive vehicle in high volume production environments which is transparent to the current workload. The apparatus of the '904 patent does not rely on the physical attachment of vibration sensing instrumentation to the automotive vehicle in order to detect and correct system imbalances.

U.S. Pat. No. 5,574,226 to Reuther et al ('226 patent), assigned to the assignee of the present invention, describes a transportable four-poster facility for testing squeaks and rattles. That facility is limited to substantially vertical movement of the suspension of the vehicle and is not directed at detecting noises which occur while the vehicle is rolling.

The above methods and apparatus are useful to check vehicles at a manufacturing site, but are not practical for remote checks of Noise, Vibration, and Harshness (NVH) of a rolling vehicle. It would be desirable to perform remote NVH analysis at a dealership, remote vehicle test site, or a race track. The present invention is also useful during launch of a new model vehicle at a vehicle assembly plant. Presently, vehicle diagnosis at a dealership requires a road test to diagnose any problem, as described in the attached Ford Service Manual for a 1997 F-150 vehicle. The road test involves many variables, including road surfaces and the skill of the driver. The vehicle may also be hoisted off the ground to evaluate the driveline, but this may unload the driveline and therefore reduce the magnitude of the problem and hinder detection thereof. The tests are time consuming and may require several iterations before the concern is detected and corrected. It would therefore be desirable to provide a vehicle test apparatus which is transportable and one which provides for accurate and rapid detection of NVH concerns.

SUMMARY OF THE INVENTION

The present invention is a transportable apparatus for detecting dynamic noises in a fully assembled automotive vehicle, and is particularly useful in detecting drive line system imbalances. The apparatus includes a trailer which has mounted thereto an angular position and speed sensor spaced from, but associated with, the drive shaft in non-contacting relationship therewith. This sensor generates a signal responsive to the speed and angular position of the drive shaft relative to a preselected reference point on the drive shaft. The apparatus also includes at least one vibration sensor located beneath the vehicle at a preselected position spaced from, but associated with, a drive shaft of the drive line system in non-contacting relationship therewith. The vibration sensor detects drive line vibration and generates a signal responsive thereto without physically contacting the drive line. The apparatus further includes a signal analyzer which receives the signals generated by the angular position and speed sensor as well as the vibration sensor and calculates an imbalance in the drive line system. The signal analyzer also presents counterbalance weight and position parameters for correcting any drive line system imbalance.

One advantage of the present invention is that the apparatus disclosed herein can detect drive line system imbalances in fully assembled automotive vehicles in remote environments. Another advantage of the present invention is

that the apparatus disclosed herein facilitates quick detection of problems without any damage to the vehicle. Still another advantage of the present invention is that the apparatus employs vibration sensors which are disposed in non-contacting relation with respect to the drive line system. Thus, there is no time or labor required to physically attach vibration sensors to the drive line system as is commonly performed in the related art.

Other features and advantages of the present invention will be readily appreciated as the same becomes better understood after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a drive line system shown in its operational mode in conjunction with an automotive vehicle.

FIG. 2 is a top view of an apparatus for detecting drive line system imbalances, according to the present invention, shown in conjunction with the automotive vehicle of FIG. 1.

FIG. 3 is a side view of the apparatus of FIG. 2 shown in conjunction with the automotive vehicle of FIG. 1.

FIG. 4 is a cross-sectional side view of a sensor position actuator of the apparatus of FIGS. 2 and 3.

FIG. 5 is a schematic view of controls for the apparatus of FIGS. 1 and 2.

FIG. 6 is a side view of an apparatus according to the present invention.

FIG. 7 is a schematic representation of an audio telemetry system for use with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and in particular to FIG. 1, an automotive vehicle is shown in silhouette at 10. The automotive vehicle 10 has a drive line system, generally indicated at 12, and an engine 14. The drive line system 12 includes a transmission 16, drive shaft 18 and a rear axle 20 as is commonly known in the art. The drive shaft 18 may include one or more tubular shafts. By way of illustration and not by way of limitation, the drive shaft 18 shown in the figures includes a front shaft 22 and a rear shaft 24. A universal joint 26, or some other suitable device, operatively couples the front shaft 22 and the rear shaft 24 together. Similarly, a universal joint 28 is located between a transmission extension 30 and the front shaft 22. A universal joint 32, or some other suitable device, is employed to couple the rear shaft 24 to the rear axle 20 through a pinion nose 34. A center bearing 36 is often employed to support the drive shaft 18 relative to the body of the automotive vehicle 10.

Referring now to FIGS. 2 and 3, an apparatus 40 for detecting drive line system imbalances in the automotive vehicle 10 according to the present invention, is generally shown at 40. The apparatus 40 includes a chassis dynamometer, generally indicated at 42, having a support surface 44 for supporting the automotive vehicle 10 while the chassis dynamometer 42 is operatively engaged by driven rear wheels 46 of the automotive vehicle 10. The chassis dynamometer 42 may also include a pair of front rollers 47, 48 for front wheels 50 of the automotive vehicle 10. In addition, the chassis dynamometer 42 includes a pair of rear rollers 52, 54 which are driven upon engagement with the rear wheels 46 of the automotive vehicle 10.

The apparatus 40 is constructed as a trailer, transportable by pulling the apparatus with a light truck. The apparatus 40 comprises a trailer having a pair of axles 43, 45, each having

a pair of wheels for supporting the rear end of the apparatus 40. The dynamometer 42 is preferably provided longitudinally between the axles 43, 45. The apparatus 40 includes a hitch 49 at the front end for attachment to a towing vehicle (not shown). The apparatus 40 further includes a hydraulic lift 51 for supporting the front end of the apparatus 40 while the vehicle 10 is being tested. Because the apparatus 40 is intended to be used for a variety of vehicles having different wheelbases, driveline configurations (e.g., driveline angle, number of supports, etc.), the sensors 58, 60, 62, 64 are mounted on adjustable supports. Preferably, the lasers are adjustable laterally, vertically and longitudinally with respect to the vehicle as described below. The adjustments may be obtained using sensors to detect the size of the vehicle (vehicle component height, width, and longitudinal spacing), or may be obtained from a lookup table which includes these data for the vehicles to be tested. Preferably, the lookup table is easily updated for additional or modified vehicles.

The apparatus 40 also includes an angular position and speed sensor 58 which is located at a preselected position spaced from, but associated with the drive shaft 18 in non-contacting relationship therewith. More specifically, the angular position and speed sensor is a fiber optic tachometer 58 which monitors the angular position and speed of the drive shaft 18 relative to a preselected reference point thereon. The preselected reference point may be a paint strip, reference sticker or any other suitable device employed to indicate the reference point on the drive shaft 18. The fiber optic tachometer 58 generates a signal responsive to the speed and angular position of the drive shaft 18 and relative to the preselected reference point thereon.

In addition, the apparatus 40 includes at least one but preferably three vibration sensors 60, 62, 64 located at a preselected position, spaced from, but associated with, the drive line 12 in non-contacting relationship therewith. More specifically, the apparatus 40 includes a vibration sensor 60 which is located in a preselected position spaced from, but in non-contacting relationship with the transmission 16 so as to sense the vibration therefrom and generate signals responsive thereto. As illustrated in the figures, the vibration sensor 60 is specifically disposed in non-contacting relationship with the transmission extension 30.

The apparatus 40 may include a vibration sensor 62 which is located at a preselected position spaced from, but in non-contacting relationship with, the center bearing 36. In this way, the vibration sensor 62 may sense the vibration from the center bearing 36 and generate signals responsive thereto. Furthermore, the apparatus 40 may also include a vibration sensor 64 which is located at a preselected position spaced from, but in non-contacting relationship, with the axle 20 so as to sense the vibration therefrom and generate signals responsive thereto. As shown in the figures, the vibration sensor 64 is specifically disposed in non-contacting relationship with respect to the pinion nose 34 of the axle 20.

The non-contacting vibration sensors 60, 62, 64 preferably comprise either a laser vibrometer, deflectometer or microwave sensor. The laser vibrometer, deflectometer and microwave sensors send energy in either a beam or a wave directed at the drive train 12 and measure the highest point of vibration in a single plane at each of the three points discussed above. More specifically, any of the sensors can be employed to measure the highest point of displacement, velocity or acceleration at the points mentioned. From this information, the vibration and any imbalance can be determined as discussed in greater detail below.

5

The apparatus 40 includes a signal analyzer 66 which receives the signals generated by the fiber optic tachometer 58 as well as the vibration sensors 60, 62, 64 and calculates any imbalance in the drive line system 12 and presents counterbalance weight and position parameters for correcting any system imbalance. The operation of the signal analyzer 66 will be discussed in greater detail below.

The apparatus 40 also includes a sensor position actuator, generally indicated at 68 in FIG. 4, and associated with each sensor 58, 60, 62, 64. The actuator 68 locates the fiber optic tachometer 58 as well as the vibration sensors 60, 62 and 64 in a proper position relative to a preselected point on the drive line. To this end, the support surface 44 on the chassis dynamometer 42 includes at least one, but preferably three bays 70 defined therein. The fiber optic tachometer 58 as well as each of the three vibration sensors 60, 62 and 64 are housed within the bays 70 in the support surface 44 of the chassis dynamometer. The sensors 58, 60, 62, 64 are operatively moveable between a first position below the support surface 44 and a second, preselected position raised from the support surface 44 and spaced from, but associated with, the drive line system 12 in non-contacting relationship as noted above. Accordingly, the sensor position actuator 68 includes a pedestal 74 and at least one motor with a gear train interconnecting the pedestal 74 with the motor. More specifically, the actuator 68 includes lateral position motors 76 and gear trains 78 for moving the sensors 58, 60, 62 and 64 in the lateral direction as viewed in FIGS. 2, 3 and 4. Similarly, the actuator 68 includes vertical position motors 80 and gear trains 82 associated therewith for moving the sensors 58, 60, 62 and 64 in the vertical direction as viewed in FIG. 3 and 4. Finally, actuator 68 includes longitudinal position motors 76 and gear trains 78, illustrated in FIG. 4, for moving the sensors 58, 60, 62 and 64 in the longitudinal direction as viewed in FIGS. 2 and 3. Alternatively, the sensors 58, 60, 62 and 64 may be mounted on slides (not shown) and adjusted manually to the correct position.

It should be noted that while the fiber optic tachometer 58 is shown mounted to a separate pedestal 84 in the figures, it may be possible to mount this device to the pedestal 74 employed with the vibration sensor 64 located opposite the pinion nose 34 on the axle 20. In addition, the sensor position actuator 68 may include an optical positioning system for locating the fiber optic tachometer 58 as well as the vibration sensors 60, 62, 64 in proper position relative to the preselected points on the drive line.

The present invention is also a method of detecting drive line system imbalances in the automotive vehicle 10 and will be described in greater detail below.

The apparatus 40 is taken to a remote site, then the automotive vehicle 10 is driven onto the chassis dynamometer. The vehicle 10 is accelerated to find its neutral running position. The sensors 58, 60, 62 and 64 are then moved from their first position below the support surface 44 on the chassis dynamometer 42 to their second preselected position disposed spaced from, but in non-contacting relationship with respect to the drive line system 12. The speed of the automotive vehicle 10 is adjusted to a predetermined value and the sensors 58, 60, 62 and 64 generate signals corresponding to the angular position and speed of the drive shaft 18 as well as the vibration in the drive line system 12, respectively. The signals are then received by the signal analyzer 66 and any imbalance in the drive line system 12 is calculated, in part, by comparing the signals generated by the sensors 58, 60, 62, 64 with influence coefficient data. The influence coefficient data may be generated for any specific drive train for any given vehicle and gives base line infor-

6

mation as a reference for calibrating the drive train system imbalance. Once this comparison is complete, the apparatus 40 presents counterbalance weight and position parameters for correcting any system imbalance.

In an alternative embodiment, the present invention includes driveline alignment detectors. Such detectors may include lasers to detect the vertical and/or lateral position of the driveshaft, driveshaft bearings, axle pinion, and/or transmission, and calculate the relative angles therebetween. Such detectors are mounted in a moveable manner similar to the sensors 58, 60, 62, 64 described above. Alternatively, such detectors comprise cameras 33, as described in U.S. Pat. No. 5,703,796 to Moradi, et al, assigned to the assignee of the present invention, which is incorporated herein in its entirety, and illustrated in FIG. 2 measuring the position of the transmission 30 extension. Preferably the cameras 33 are mounted in a manner similar to the sensors described above to provide for various vehicle sizes.

Further analysis of the NVH of the vehicle 10 is performed using an audio detection system 86 as illustrated in FIG. 7. The system 86 includes a microphone 87, preferably worn by an operator (not shown) who drives the vehicle on the apparatus 40. Alternatively, the microphone may be positioned in the vehicle, such as by pinning the microphone to the seat near where a driver's ear would be positioned. The microphone 87 picks up a sound pressure signal produced by the vehicle. In a preferred embodiment, the system 86 includes a telemetry transmitter 88 and receiver 91, so the signal picked up by the microphone 87 can be transmitted to a recorder 92 and analyzer 93 without hard wires. Thus, the microphone 87 is inside the vehicle and the door is closed without wired being trapped by the door. This facilitates expedient testing and avoids damage to the vehicle and the equipment of the system 86. With the telemetry system, an antenna 89, 90 is provided each at the transmitter 88 and at the receiver 91. In a preferred embodiment, the system 86 transmits broad band radio wave through the window glass as described above. The recorded sound waves are generally within the range of 0-22 KHz.

In the manner described above, drive line system vibration balancing and alignment may be performed in a fully assembled automotive vehicle in remote environment in a way which is substantially transparent to the customer and the evaluation may be performed quickly and accurately by a technician. In addition, drive line system balancing and alignment may be performed without the physical attachment of any vibration sensing instrumentation to the automotive vehicle in order to detect and correct system imbalances. Finally, data acquisition may be performed to obtain empirical data for vehicle analysis and documentation.

One skilled in the art further recognizes that although the description has been directed to driveline vibrations, the portable dynamometer described above is useful for many other dynamic vehicle diagnostics. These include tire/wheel vibration, engine noise, exhaust noise, transmission/axle gear noise, transfer case operation, ABS and other brake functions, squeaks and rattles, and other dynamic vehicle functions. Furthermore, one skilled in the art would appreciate that cam plates could be added to the rollers of the dynamometer to add simulated road inputs to induce squeaks and rattles, in a manner similar to the machines commercially available from the Burke-Porter company for stationary sites for squeak and rattle analysis, as described in the '226 patent, which is incorporated herein by reference.

The present invention has been described in an illustrative manner. It is to be understood that the terminology which

has been used is intended to be in the nature of words of description rather than of limitation. Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced 5 otherwise than as specifically described.

What is claimed is:

1. A mobile apparatus for detecting drive line system imbalances in an automotive vehicle, said apparatus comprising:

an angular position and speed sensor located at a position spaced from, but associated with, a drive shaft of a drive line system in a non-contacting relationship therewith, said sensor generating a signal responsive to speed and angular position of the drive shaft relative to a preselected reference point thereon;

at least one vibration sensor located at position, spaced from, but associate with, the drive line system in non-contacting relationship therewith, said at least one vibration sensor detecting drive line vibration and generating a signal responsive thereto;

an angular sensor for detecting an angular alignment of the drive line system;

a signal analyzer which receives the signals generated by said angular position and speed sensor as well as said at least one vibration sensor and calculates any imbalance in the drive line system and presents counterbalance weight and position parameters for correcting any system imbalance;

a trailer having a hitch for attachment to a towing vehicle for transporting the apparatus for measuring the drive line system; and

wherein said angular sensor comprises a pair of perception cameras for sending a pair of signals to the signal analyzer for determining the angular alignment of the drive line system and calculating a corrective shim thickness between a center bearing and the vehicle.

2. An apparatus as set forth in claim 1, wherein said at least one vibration sensor is located at a position spaced from, but in non-contacting relationship with, a transmission of the drive line system so as to sense the vibration therefrom and generate signals responsive thereto.

3. An apparatus as set forth in claim 1, wherein said at least one vibration sensor is located at a position spaced from, but in non-contacting relationship with, a center bearing of the drive line system so as to sense the vibration therefrom and generate signals responsive thereto.

4. An apparatus as set forth in claim 1, wherein said at least one vibration sensor is located at a position spaced from, but in non-contacting relationship with, an axle of the drive line system so as to sense the vibration therefrom and generate signals responsive thereto.

5. An apparatus as set forth in claim 1, wherein said apparatus includes at least three vibration sensors located at positions spaced from, but in non-contacting relationship with, a transmission, a center bearing and an axle, respectively, of the drive line system so as to sense the vibration therefrom and generate signals responsive thereto.

6. An apparatus as set forth in claim 5, wherein said at least three vibration sensors sense the vibration in a single plane generated by the transmission, the center bearing and the axle, respectively.

7. An apparatus as set forth in claim 1, wherein said angular position and speed sensor is a fiber optic tachometer which monitors the angular position and speed of the drive shaft relative to the reference point thereon.

8. An apparatus as set forth in claim 1, wherein said at least one vibration sensor is selected from the group consisting of a laser vibrometer, a deflectometer, and a micro-wave sensor.

9. An apparatus as set forth in claim 1, further comprising an audio sensor located at a position inside a passenger compartment of the vehicle in non-permanent manner, said audio sensor generating an audio signal responsive to a noise in the passenger compartment.

10. An apparatus according to claim 9, wherein the audio signal is transmitted from a transmitter inside the vehicle to a receiver outside the vehicle using audio telemetry.

11. An apparatus as set forth in claim 1, wherein said apparatus includes a chassis dynamometer having a support surface for supporting the automotive vehicle while said chassis dynamometer is operatively engaged by drive wheels of the automotive vehicle, said support surface including at least one bay defined therein, said angular position and speed sensor as well as said at least one vibration sensor housed within said at least one bay and being operatively moveable between a first position below said support surface and a second position raised above said support surface and into said positions relative to the drive line system.

12. An apparatus for detecting drive line system imbalances in an automotive vehicle, said apparatus comprising:

a chassis dynamometer having a support surface for supporting an automotive vehicle while said chassis dynamometer is operatively engaged by driven wheels of the automotive vehicle, said support surface including at least one bay defined therein;

an angular position and speed sensor and at least one vibration sensor housed with said bay in said support surface of said chassis dynamometer, said sensors being operatively moveable between a first position below said support surface and a second position raised above said support surface and spaced from, but associated with, a drive shaft of a drive line system in non-contacting relationship therewith;

said angular position and speed sensor generating a signal responsive to speed and angular position of the drive shaft relative to a preselected reference point therein, said at least one vibration sensor detecting drive line vibration and generating a signal responsive thereto;

an angular sensor for detecting an angular alignment of the drive line system;

a signal analyzer which receives the signals generated by said angular position and speed sensor as well as said at least one vibration sensor and calculates any imbalance in the drive line system and presents counterbalance weight and position parameters for correcting any system imbalance;

a trailer having a hitch for attachment to a towing vehicle for transporting the apparatus for measuring the drive line system; and

wherein said angular sensor comprises a pair of perception cameras for sending a pair of signals to the signal analyzer for determining the angular alignment of the driveline and calculating a corrective shim thickness between the center bearing and the vehicle.

13. An apparatus as set forth in claim 12, wherein said apparatus includes at least three vibration sensors located at preselected positions spaced from, but in non-contacting relationship with, a transmission, a center bearing and an axle, respectively of the drive line system so as to sense the vibration therefrom and generate signals responsive thereto.

9

14. An apparatus as set forth in claim 12, wherein said apparatus includes a sensor position actuator which locates said angular position and speed sensor as well as said at least one vibration sensor in a proper position relative to the drive line system.

15. An apparatus as set forth in claim 14, wherein said sensor position actuator includes an optical positioning system for locating said angular position and speed sensor as well as said at least one vibration sensor in a proper position relative to a preselected point on the drive line system.

16. An apparatus as set forth in claim 14, wherein said sensor position actuator includes a pedestal and at least one motor with a gear train interconnecting said pedestal and said motor, said angular position and speed sensor as well as said at least one vibration sensor supported by said pedestal and moveable thereby into.

17. A method of detecting drive line system imbalances in an automotive vehicle, said method including the steps of: transporting a transportable chassis dynamometer;

positioning an automotive vehicle on the portable chassis dynamometer having a support surface for supporting the automotive vehicle while said chassis dynamometer is operatively engaged by driving wheels of the automotive vehicle, moving an angular position and speed sensor and at least one vibration sensor housed within a bay in said support surface of said chassis dynamometer from a first position below said support surface to a second position above said support surface and spaced from, but associated with a driveshaft of a driveline of the vehicle in a noncontacting relationship therewith;

generating a signal in response to an angular position and speed of a drive shaft of the drive line system from a sensor placed in non-contacting relationship therewith;

10

detecting vibration in the drive line system from at least one sensor and disposed spaced from, but in non-contacting relationship with respect to the drive line system and generating a signal corresponding thereto;

determining an angular relationship of the driveline to the vehicle; and

calculating any imbalance in the drive line system based on said signals from the angular position and speed sensor as well as the at least one vibration sensor and determining a corrective counterweight and position thereof to eliminate any system imbalance.

18. A method as set forth in claim 17, wherein the steps of generating signal in response to the angular position and speed at the drive shaft as well as generating signal corresponding to drive line vibration include moving the sensors into a non-contacting position with respect to the drive line system.

19. A method as set forth in claim 18, wherein the step of determining corrective counterweight and position include comparing any imbalance in the drive line system with reference data determined for the specific drive line system being balanced.

20. A method as set forth in claim 17, including the step of accelerating the automotive vehicle until the automotive vehicle reaches a predetermined neutral running position.

21. A method as set forth in claim 17, further comprising the step of collecting audible NVH data using audio telemetry.

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